



# **NCHRP 14-31 Framework for Pavement Maintenance Database System**



# Today's Presenters

- **NCHRP 14-31 Framework for Pavement Maintenance Database System**
  - **Pavia Systems**  
George White, CEO/Co-Founder  
Steven Velozo, CTO

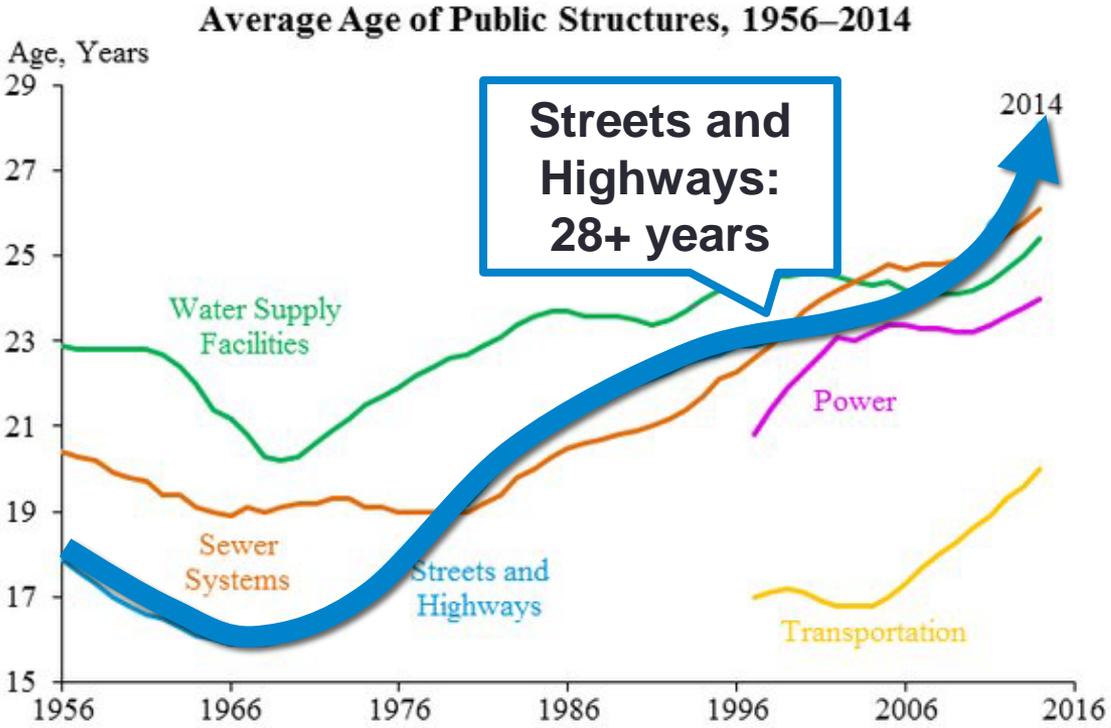


**A Transportation infrastructure is  
fundamental to our way of life.**

**Why we do what we do...**



# Our infrastructure is aging...



AMERICA'S G.P.A. **D+** ESTIMATED INVESTMENT NEEDED BY 2020: **\$3.6 TRILLION**

**INFRASTRUCTURE GRADES FOR 2013**

|          |    |                  |    |                           |    |
|----------|----|------------------|----|---------------------------|----|
| ENERGY   | D+ | SCHOOLS          | D  | PUBLIC PARKS & RECREATION | C- |
| TRANSIT  | D  | ROADS            | D  | RAIL                      | C+ |
| PORTS    | C  | INLAND WATERWAYS | D- | BRIDGES                   | C+ |
| AVIATION | D  | WASTEWATER       | D  | SOLID WASTE               | B- |
| LEVELS   | D- | HAZARDOUS WASTE  | D  | DRINKING WATER            | D  |
| DAMS     | D  |                  |    |                           |    |

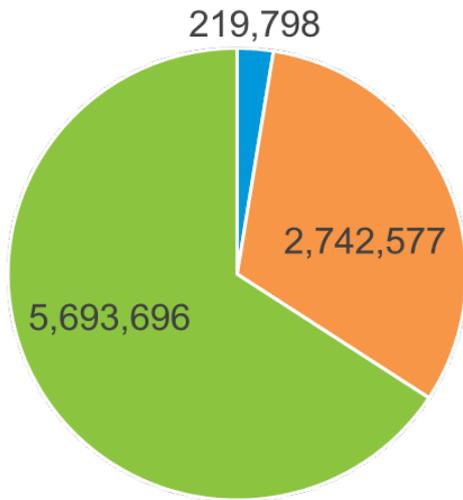
A: EXCEPTIONAL, B: GOOD, C: MIDDLED, D: POOR, F: FAILING  
Each category was evaluated on the basis of capacity, condition, funding, future need, operation and maintenance, public safety, resilience, and innovation

Sources: Bureau of Economic Analysis, ASCE



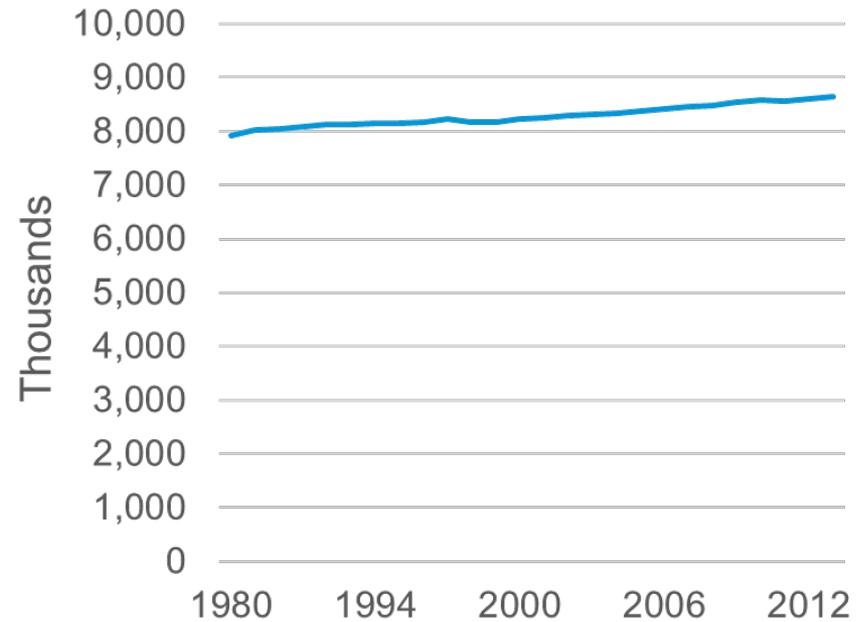
# And we're not "adding" lane miles...

Lane Miles by Functional Class

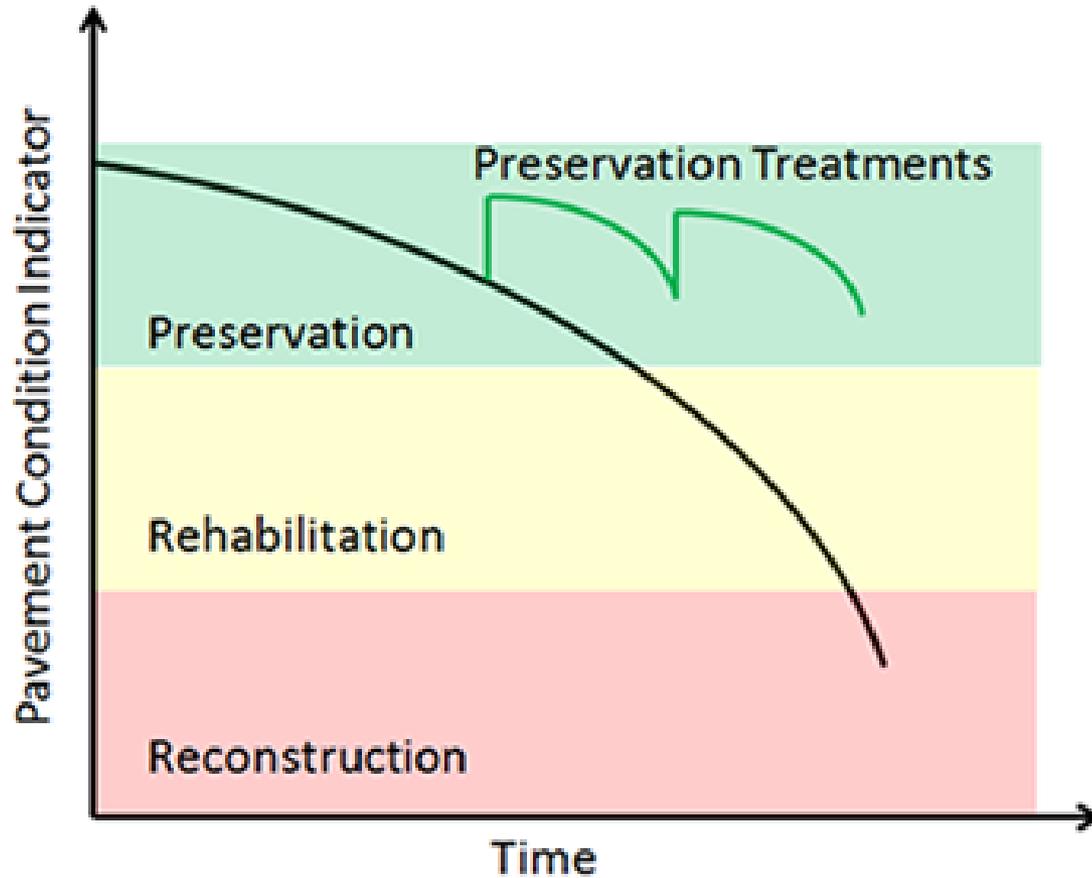


■ Interstate ■ Arterial Collector ■ Local

Total Lane Miles



# We're working to preserve and maintain...



**Was this the right treatment at the right time to extend my pavement life effectively?**

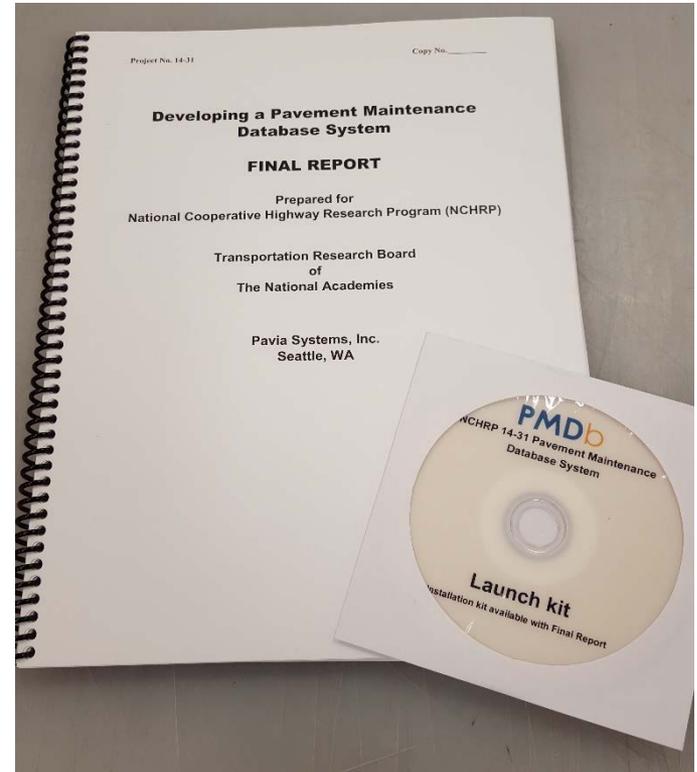


# Are there maintenance or preservation activities I should put in to my “toolbox”?



# NCHRP 14-31: Objectives

- Develop a database system of pavement-maintenance actions, materials, and methods, and their effectiveness.
- Include uniform descriptions of maintenance activities, basis of measurement, costs, pavement condition, and other relevant data



# Team and Panel

**paviasystems**



applied pavement  
TECHNOLOGY



# The “cliff notes” of the approach

## 1. Define Data Elements and Terms

- Information Review
- Establish Data Categories and Elements
- Panel Review and Feedback

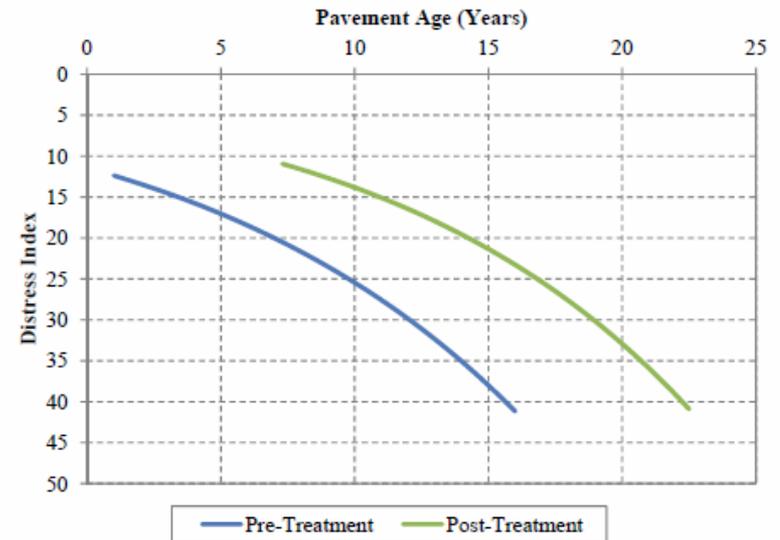
## 2. Develop Database Framework

- Develop draft version of database system
- Address feedback on system
- Obtain and enter data from transportation agencies (limited)
- Refine database system



# Examples of desired analysis to answer big questions

- Develop pre- and post-treatment performance trends using time series data from database
- Analyze performance benefits when compared to pre-treatment performance
- Compare benefits and unit costs to arrive at benefit-cost ratios for various treatments using different performance indicators



# What are the data elements needed?

## Pavement Section

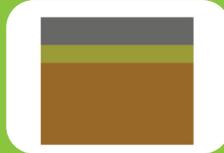
### Inventory Data



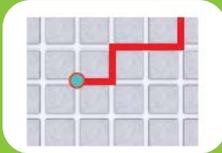
Traffic



Climate



Structure



Location

### Maintenance Data



Materials



Placement



Cost

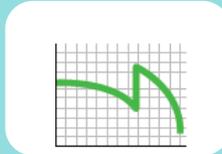


Treatment

### Condition Data



Distress



Cond.  
Index



Ride /  
Friction



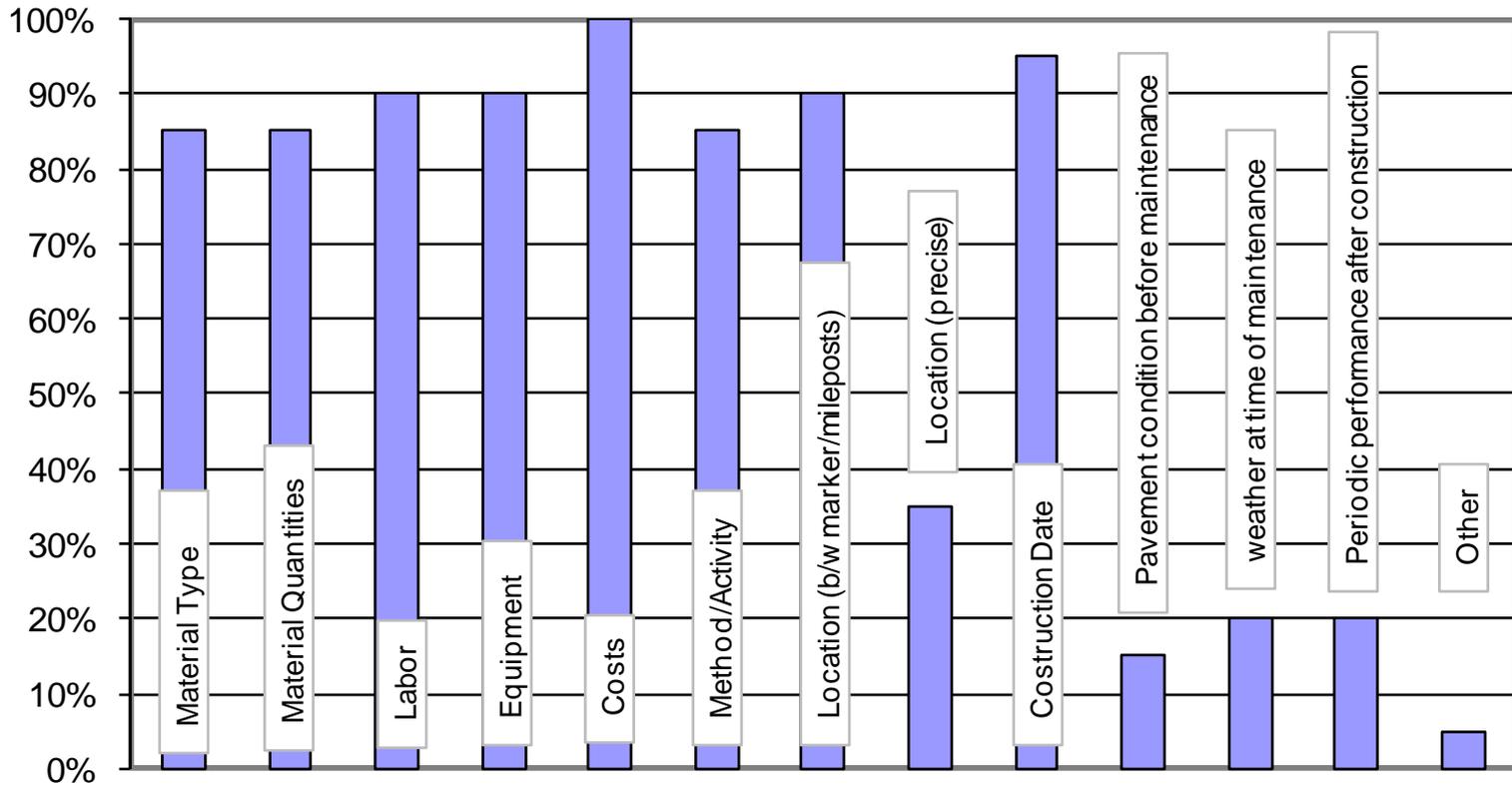
Noise



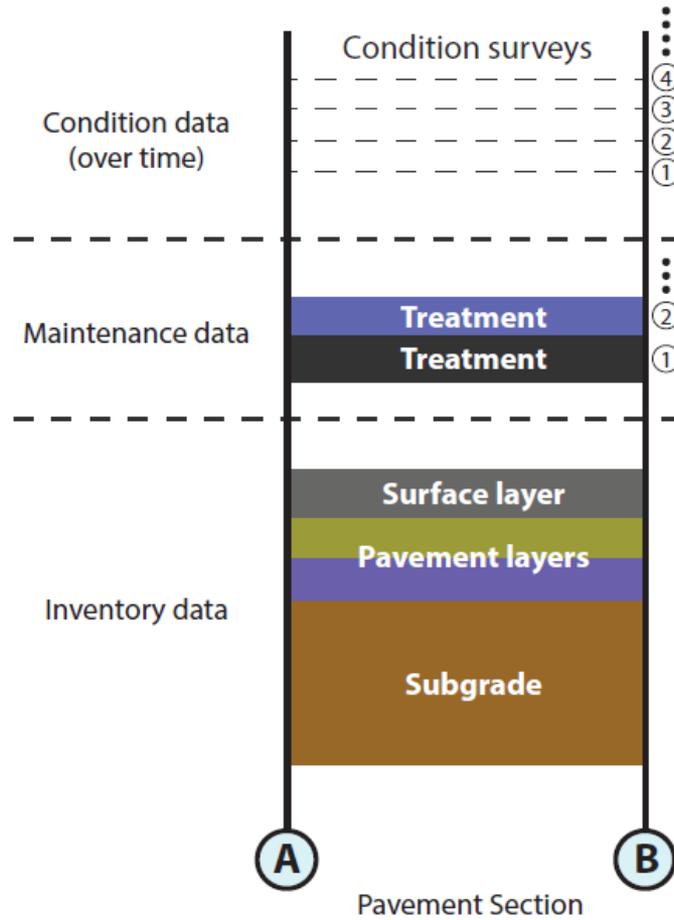
Structural



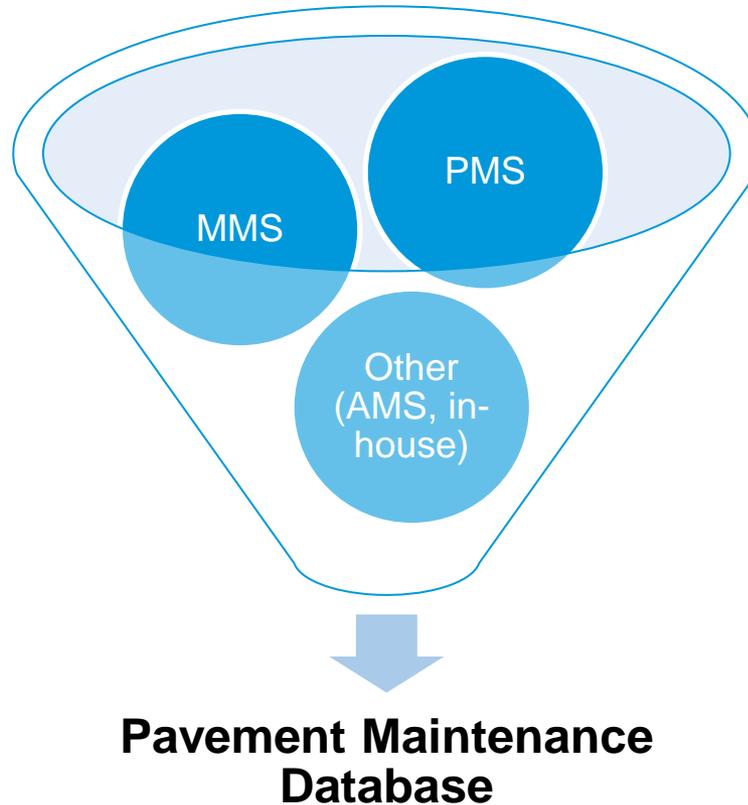
# What data should be captured, when, by who?



# Anatomy of a pavement section



# Where does that data currently reside?



# Definition of terms and data elements

Provide common definition of the elements, terms, and values to create a **common lexicon around which to persist data.**

| Treatments Definitions for Asphalt-Surfaced Pavements | Treatment Definitions for Concrete-Surfaced Pavements |
|---|---|
| Crack Filling/Sealing                                 | Joint/Crack Sealing                                   |
| Asphalt Patching                                      | Slab Stabilization/Slab Jacking                       |
| Fog Seals/Rejuvenators                                | Diamond Grinding/Grooving                             |
| Chip Seals  | Partial-Depth Repairs                                 |
| Slurry Seals  | Full-Depth Repairs                                    |
| ...   | ...   |



# Inventory Data Elements

| Data Element              | Attributes/Description  |
|---------------------------|---|
| Pavement Section ID       | <ul style="list-style-type: none"><li>• Unique identifier for a section of a pavement with a homogeneous cross section.</li></ul>   |
| Pavement Section Location | <ul style="list-style-type: none"><li>• Route, Direction, Lane, Begin Reference Point, End Reference Point (milepost, accumulated route mile)</li><li>• GPS coordinates of start and end points of section (when available)</li><li>• Station/Offset (when available)</li></ul> |
| Functional Classification | <ul style="list-style-type: none"><li>• Route type (Interstate, Principal Arterials, Minor Arterials, Collectors, Local Roads, etc.)</li></ul>  |
| Climatic Zone             | <ul style="list-style-type: none"><li>• Dry Freeze, Wet Freeze, Dry No Freeze, Wet No Freeze</li></ul>  |
| Traffic                   | <ul style="list-style-type: none"><li>• Year</li><li>• Traffic Count (AADT, ADT)</li><li>• % commercial/truck traffic</li></ul>   |



# Inventory Data Elements

| Data Element                         | Attributes/Description  |
|--------------------------------------|---|
| Pavement Surface                     | <ul style="list-style-type: none"><li>• Material (asphalt, concrete, existing preservation treatment)</li><li>• Thickness</li></ul>   |
| Pavement Layers (one for each layer) | <ul style="list-style-type: none"><li>• Layer number</li><li>• Material (aggregate type/gradation, binder, additives, other proprietary products etc.)</li><li>• Thickness</li><li>• Function (base, structural, wearing, repair)</li></ul> |
| Pavement Subgrade                    | <ul style="list-style-type: none"><li>• Subgrade material and other relevant information</li></ul>  |
| Major Rehabilitation History         | <ul style="list-style-type: none"><li>• Month/year construction started</li><li>• Month/year open to traffic</li><li>• Type of work performed</li></ul>   |



# Maintenance Data Elements

| Data Element                     | Attributes/Description   |
|----------------------------------|--|
| Maintenance Section Unique ID    | <ul style="list-style-type: none"><li>• Unique identifier for the pavement section on which the maintenance treatment is placed</li></ul>  |
| Maintenance Treatment            | <ul style="list-style-type: none"><li>• Treatment name</li><li>• Treatment type (routine, reactive, preventive)</li><li>• Reason for treatment placement (to identify the if the treatment was placed to address safety, noise, or other conditions)</li></ul> |
| Maintenance Section Location     | <ul style="list-style-type: none"><li>• Pavement section location data attribute type (to be linked using the Unique IDs)</li></ul>  |
| Materials Data (when applicable) | <ul style="list-style-type: none"><li>• Aggregate type/gradation</li><li>• Binder</li><li>• Additive</li><li>• Proprietary product and manufacturer</li></ul>  |



# Maintenance Data Elements

| Data Element                | Attributes/Description   |
|-----------------------------|--|
| Treatment Placement Details | <ul style="list-style-type: none"><li>• Treatment number</li><li>• Thickness</li><li>• Placement procedure/standard/specifications</li><li>• Equipment used</li><li>• Facility downtime</li><li>• Construction start date</li><li>• Open to traffic date</li></ul>   |
| Treatment Service Details   | <ul style="list-style-type: none"><li>• Pre-treatment condition (link to Pavement Condition data element)</li><li>• Treatment service termination month/date (link to month/date of maintenance treatment placement or month/date of major rehabilitation),</li><li>• Reason for treatment service termination (condition deterioration, safety concerns, other pavement improvement projects, etc.)</li></ul> |



# Maintenance Data Elements

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| Data Element          | Attributes/Description  |
|-----------------------|---|
| Treatment Cost        | <ul style="list-style-type: none"><li>• Labor</li><li>• Equipment</li><li>• Materials</li><li>• Pay items</li><li>• Traffic mobilization</li><li>• Overhead</li><li>• Other</li></ul> |
| Contracting Mechanism | <ul style="list-style-type: none"><li>• Contract type (In-house, performed by contractor, warranty, etc.)</li></ul>   |

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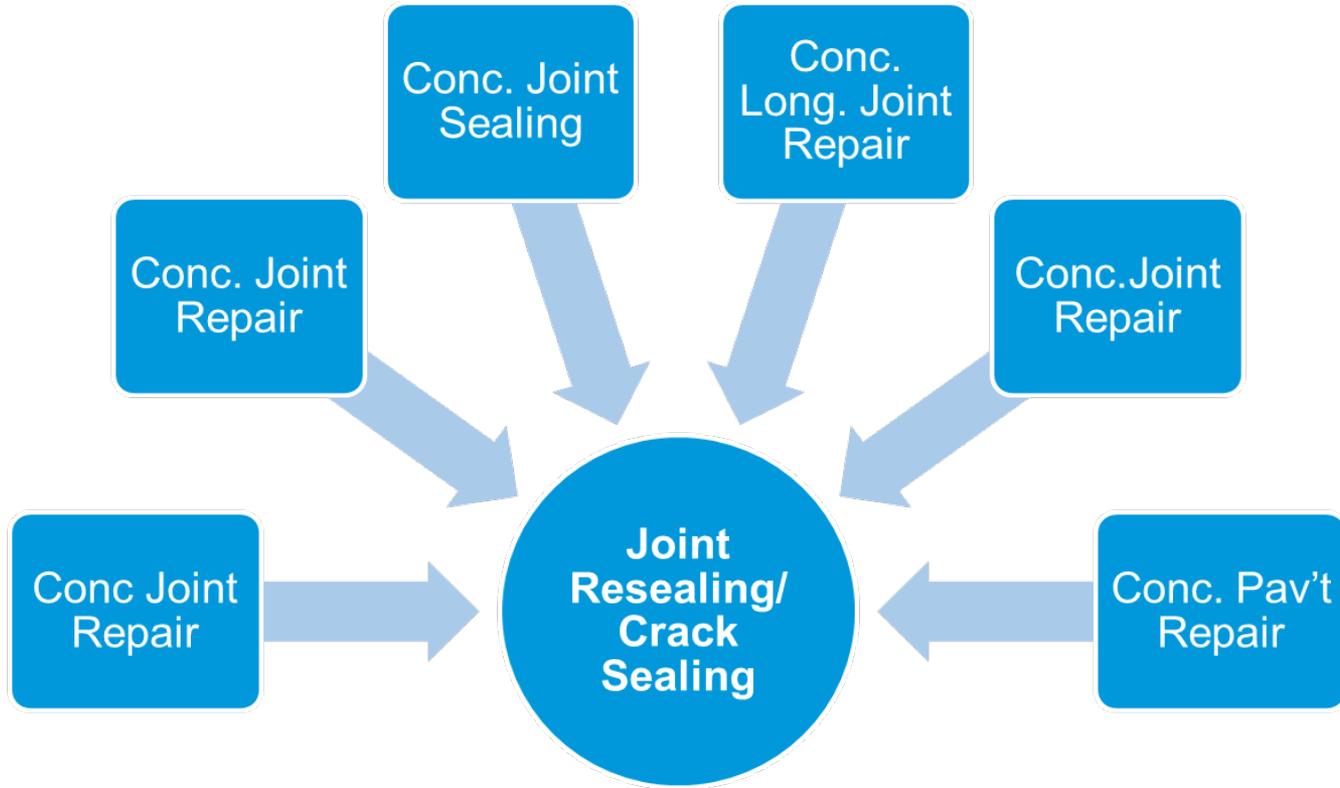


# Pavement Condition Data Elements

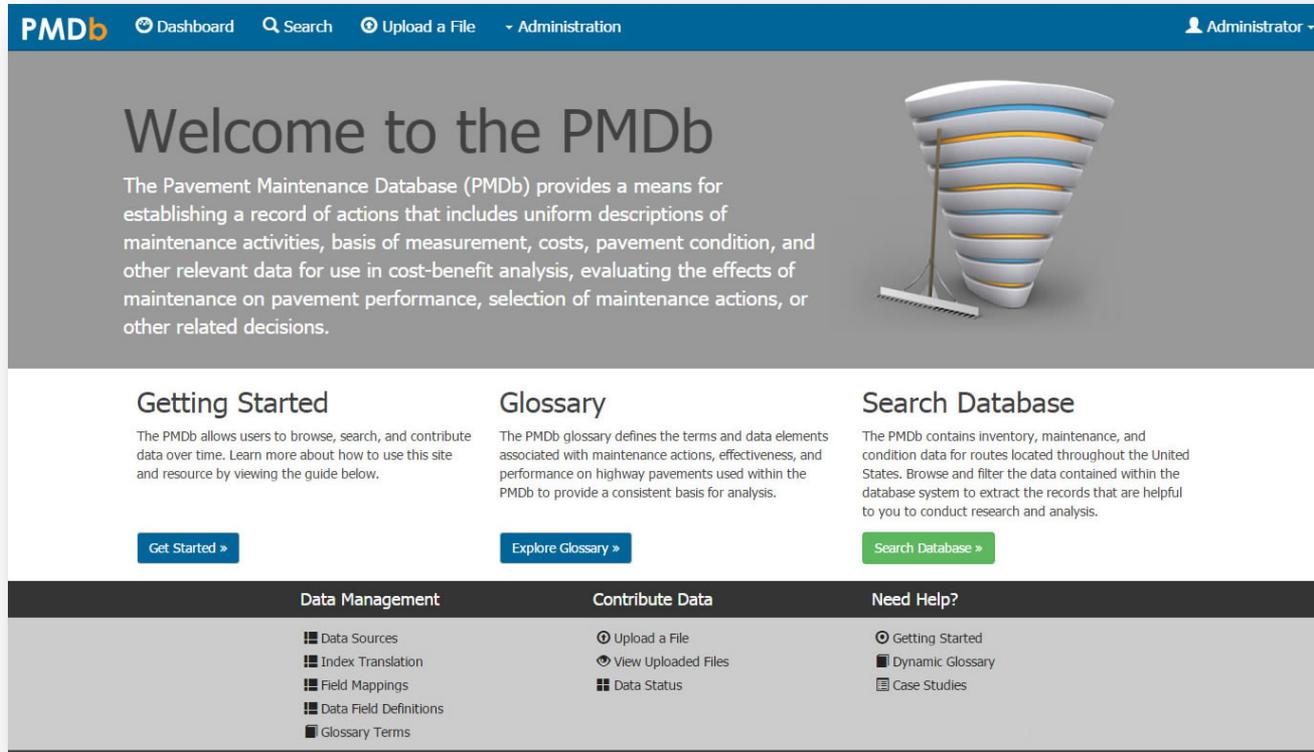
| Data Element              | Attributes/Description  |
|---------------------------|---|
| Raw Distress Data         | <ul style="list-style-type: none"><li>• Distress type</li><li>• Severity</li><li>• Quantity</li></ul>   |
| Overall Condition Indices | <ul style="list-style-type: none"><li>• PCI, PCR, other composite indices used</li></ul>  |
| Friction Data             | <ul style="list-style-type: none"><li>• Friction indices name (Friction Number, other friction indices used)</li><li>• Friction value</li></ul> |
| Ride Quality              | <ul style="list-style-type: none"><li>• Ride indices name (IRI, PI, PSI, RQI, other indices used)</li><li>• Ride indices value</li></ul>        |
| Noise Data                | <ul style="list-style-type: none"><li>• Pavement-tire noise data</li></ul>  |
| Structural Condition Data | <ul style="list-style-type: none"><li>• Data from non-destructive testing (e.g. elastic modulus data computed using FWD data)</li></ul>         |
| Data Collection Method    | <ul style="list-style-type: none"><li>• Manual/automated</li><li>• Type of equipment used</li></ul>   |



# The importance of common definitions and consistent data collection.



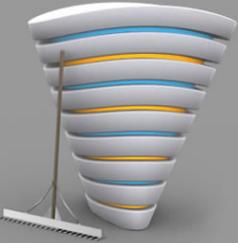
# Developing a database framework



**PMDb** [Dashboard](#) [Search](#) [Upload a File](#) [Administration](#) Administrator ▾

## Welcome to the PMDb

The Pavement Maintenance Database (PMDb) provides a means for establishing a record of actions that includes uniform descriptions of maintenance activities, basis of measurement, costs, pavement condition, and other relevant data for use in cost-benefit analysis, evaluating the effects of maintenance on pavement performance, selection of maintenance actions, or other related decisions.



### Getting Started

The PMDb allows users to browse, search, and contribute data over time. Learn more about how to use this site and resource by viewing the guide below.

[Get Started »](#)

### Glossary

The PMDb glossary defines the terms and data elements associated with maintenance actions, effectiveness, and performance on highway pavements used within the PMDb to provide a consistent basis for analysis.

[Explore Glossary »](#)

### Search Database

The PMDb contains inventory, maintenance, and condition data for routes located throughout the United States. Browse and filter the data contained within the database system to extract the records that are helpful to you to conduct research and analysis.

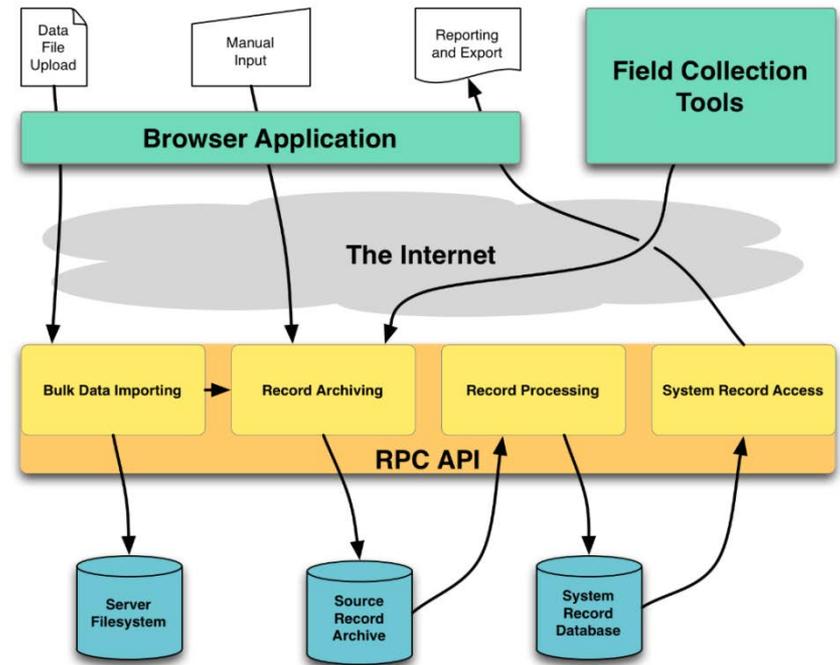
[Search Database »](#)

| Data Management   | Contribute Data   | Need Help?  |
|---|---|---|
| <ul style="list-style-type: none"><li>Data Sources</li><li>Index Translation</li><li>Field Mappings</li><li>Data Field Definitions</li><li>Glossary Terms</li></ul> | <ul style="list-style-type: none"><li>Upload a File</li><li>View Uploaded Files</li><li>Data Status</li></ul> | <ul style="list-style-type: none"><li>Getting Started</li><li>Dynamic Glossary</li><li>Case Studies</li></ul> |

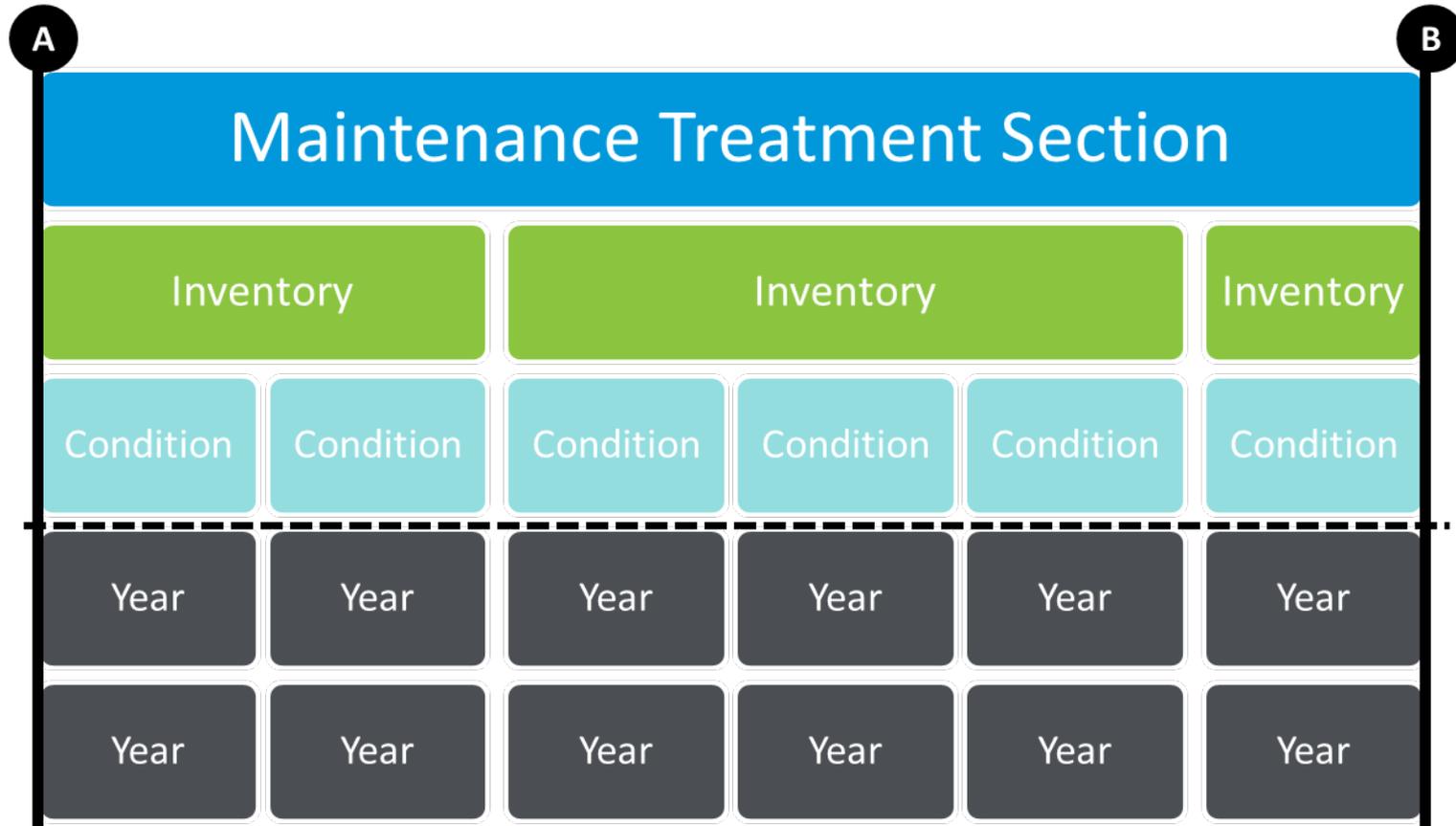


# What Is The PMDb?

- Database and accompanying browser application
- Event-based data model for segments unique based on location and time
- Maps back to source data
- Allows us to cluster data to perform data aggregations



# PMDb: Source Record Segment

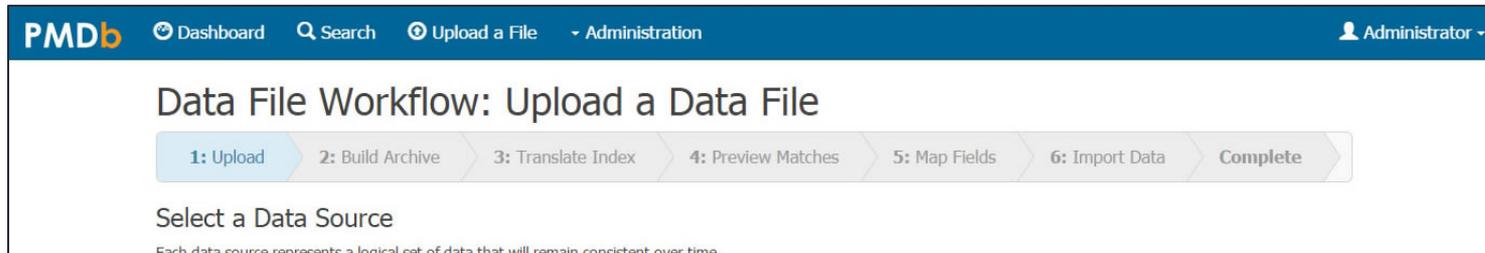


# PMDb: System Record Segment

| A         | Maintenance Treatment Section |           |           |           |           | B |
|-----------|-------------------------------|-----------|-----------|-----------|-----------|---|
| Inventory | Inventory                     | Inventory |           |           | Inventory |   |
| Condition | Condition                     | Condition | Condition | Condition | Condition |   |
| Year      | Year                          | Year      | Year      | Year      | Year      |   |
| Year      | Year                          | Year      | Year      | Year      | Year      |   |



# Workflows for combining and cleansing data



**PMDb** Dashboard Search Upload a File Administration Administrator

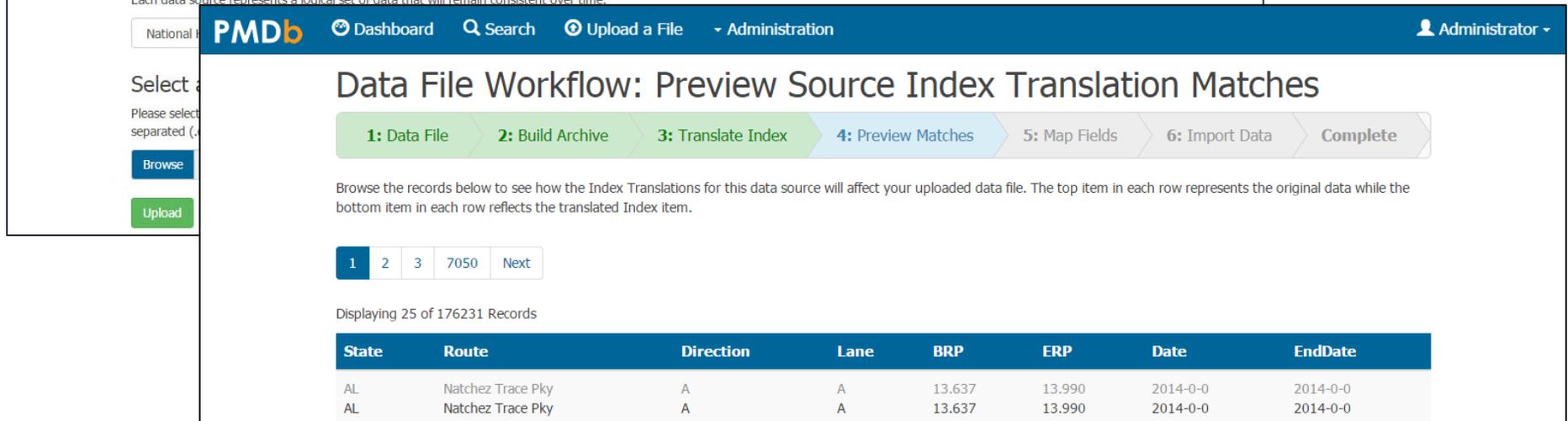
## Data File Workflow: Upload a Data File

1: Upload 2: Build Archive 3: Translate Index 4: Preview Matches 5: Map Fields 6: Import Data Complete

Select a Data Source

Each data source represents a logical set of data that will remain consistent over time.

National



**PMDb** Dashboard Search Upload a File Administration Administrator

## Data File Workflow: Preview Source Index Translation Matches

1: Data File 2: Build Archive 3: Translate Index 4: Preview Matches 5: Map Fields 6: Import Data Complete

Browse the records below to see how the Index Translations for this data source will affect your uploaded data file. The top item in each row represents the original data while the bottom item in each row reflects the translated Index item.

1 2 3 7050 Next

Displaying 25 of 176231 Records

| State | Route             | Direction | Lane | BRP    | ERP    | Date     | EndDate  |
|-------|-------------------|-----------|------|--------|--------|----------|----------|
| AL    | Natchez Trace Pky | A         | A    | 13.637 | 13.990 | 2014-0-0 | 2014-0-0 |
| AL    | Natchez Trace Pky | A         | A    | 13.637 | 13.990 | 2014-0-0 | 2014-0-0 |



# Workflows for query and extraction

## Search the Pavement Maintenance Database

Set filters to find matching route segments in the Pavement Maintenance Database. Matching system data records can be downloaded.

### Active Filters

Filter **Inventory**->Pavement Surface: Surface Material for:

Filter **Condition**->Overall Condition Index: PCI for values between:

and

[Add a Filter](#) [Apply Filter\(s\)](#)

### Matching Routes

|   |                         |                         |            |
|---|-------------------------|-------------------------|------------|
| <b>MI M-28</b><br>Between ARM 10 and 16<br>Matches: 6 miles   | <b>Inventory</b><br>90  | <b>Condition</b><br>80  | <b>270</b> |
| <b>MI US-41</b><br>Between ARM 11 and 22<br>Matches: 11 miles | <b>Inventory</b><br>141 | <b>Condition</b><br>111 | <b>423</b> |

[Download Source Records](#) [Download System Data](#)

| State | Route    | BARM | EARM | RouteURL            | RuralCod | Functional | Administrative | Minimum | Maximum | Direction | Lane | RecordNo         | Type           | Category | Field | Value    |
|-------|----------|------|------|---------------------|----------|------------|----------------|---------|---------|-----------|------|------------------|----------------|----------|-------|----------|
| CO    | 104th Av | 0    | 1    | http://pm.Large Urb | Unknown  | Unknown    | Unknown        | 0       | 8.68    | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 11100    |
| CO    | 104th Av | 1    | 2    | http://pm.Large Urb | Unknown  | Unknown    | Unknown        | 0       | 8.68    | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 17874    |
| CO    | 104th Av | 2    | 3    | http://pm.Large Urb | Unknown  | Unknown    | Unknown        | 0       | 8.68    | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 21260.75 |
| CO    | 104th Av | 3    | 4    | http://pm.Large Urb | Unknown  | Unknown    | Unknown        | 0       | 8.68    | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 17260.8  |
| CO    | 104th Av | 4    | 5    | http://pm.Large Urb | Unknown  | Unknown    | Unknown        | 0       | 8.68    | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 20165.8  |
| CO    | 104th Av | 5    | 6    | http://pm.Large Urb | Unknown  | Unknown    | Unknown        | 0       | 8.68    | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 42051    |
| CO    | 104th Av | 6    | 7    | http://pm.Large Urb | Unknown  | Unknown    | Unknown        | 0       | 8.68    | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 50622.6  |
| CO    | 104th Av | 7    | 8    | http://pm.Large Urb | Unknown  | Unknown    | Unknown        | 0       | 8.68    | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 39370    |
| CO    | 104th Av | 8    | 9    | http://pm.Large Urb | Unknown  | Unknown    | Unknown        | 0       | 8.68    | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 39370    |
| CA    | 10th Av  | 0    | 1    | http://pm.Large Urb | Urban    | Pris       | Unknown        | 0       | 0.302   | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 23250    |
| CO    | 10th St  | 0    | 1    | http://pm.Large Urb | Urban    | Pris       | Unknown        | 0       | 10.222  | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 30106    |
| CO    | 10th St  | 1    | 2    | http://pm.Large Urb | Urban    | Pris       | Unknown        | 0       | 10.222  | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 12670.75 |
| CO    | 10th St  | 2    | 3    | http://pm.Large Urb | Urban    | Pris       | Unknown        | 0       | 10.222  | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 14835    |
| CO    | 10th St  | 3    | 4    | http://pm.Large Urb | Urban    | Pris       | Unknown        | 0       | 10.222  | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 14835    |
| CO    | 10th St  | 4    | 5    | http://pm.Large Urb | Urban    | Pris       | Unknown        | 0       | 10.222  | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 14835    |
| CO    | 10th St  | 5    | 6    | http://pm.Large Urb | Urban    | Pris       | Unknown        | 0       | 10.222  | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 20377    |
| CO    | 10th St  | 6    | 7    | http://pm.Large Urb | Urban    | Pris       | Unknown        | 0       | 10.222  | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 25919    |
| CO    | 10th St  | 7    | 8    | http://pm.Large Urb | Urban    | Pris       | Unknown        | 0       | 10.222  | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 25251.5  |
| CO    | 10th St  | 8    | 9    | http://pm.Large Urb | Urban    | Pris       | Unknown        | 0       | 10.222  | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 24584    |
| CA    | 11th Av  | 0    | 1    | http://pm.Large Urb | Urban    | Mtr        | Unknown        | 0       | 1.24    | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 15265    |
| CA    | 11th Av  | 1    | 2    | http://pm.Large Urb | Urban    | Mtr        | Unknown        | 0       | 1.24    | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 15265    |
| DE    | 11th St  | 7    | 8    | http://pm.Large Urb | Urban    | Pris       | Unknown        | 7411    | 8.23    | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 10051.67 |
| CA    | 11th St  | 6    | 7    | http://pm.Large Urb | Urban    | Pris       | Unknown        | 0       | 15.316  | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 19911    |
| CO    | 120th Av | 12   | 13   | http://pm.Large Urb | Urban    | Pris       | Unknown        | 12.199  | 300.42  | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 42236    |
| CO    | 120th Av | 13   | 14   | http://pm.Large Urb | Urban    | Pris       | Unknown        | 12.199  | 300.42  | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 36685    |
| CO    | 120th Av | 14   | 15   | http://pm.Large Urb | Urban    | Pris       | Unknown        | 12.199  | 300.42  | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 46892    |
| CO    | 120th Av | 15   | 16   | http://pm.Large Urb | Urban    | Pris       | Unknown        | 12.199  | 300.42  | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 39287    |
| CO    | 120th Av | 16   | 17   | http://pm.Large Urb | Urban    | Pris       | Unknown        | 12.199  | 300.42  | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 21724    |
| CO    | 120th Av | 293  | 294  | http://pm.Large Urb | Urban    | Pris       | Unknown        | 12.199  | 300.42  | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 29897    |
| CO    | 120th Av | 294  | 295  | http://pm.Large Urb | Urban    | Pris       | Unknown        | 12.199  | 300.42  | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 29897    |
| CA    | 120th Av | 946  | 946  | http://pm.Large Urb | Urban    | Pris       | Unknown        | 12.199  | 300.42  | A         | A    | NHPM Tra Traffic | Inventory AADT | 0        |       | 14848.4  |



# Existing Data Gaps Identified

- Reason for treatment application (whether placed to address noise, friction, seal surface etc.)
- Cost of treatment on a project-by-project basis
- Equipment used to perform maintenance activity
- Materials data and quantities used
- Condition of underlying pavement prior to treatment placement
- Accurate location of maintenance treatment and link between maintenance data and PMS data
- Inconsistency in treatment identification
- Absence of treatment history



# Key Takeaways

- There are a wide range of data collection practices and policies and gaps to resolve.
- The questions we seek to answer demand consistency in that data over time and a persistent framework
- This database framework provides a basis for that effort



# And as research goes...what's next?

**Implementation– identify remaining gaps and efforts needed:**

- Data collection best practices “**what**” – resolve gaps!
- Guidance for “**how**” to obtain data
- Guidance for working with other data providers “**who**”
- Common key performance measures “**why**”



**Thank you.**

